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ABSTRACT

This report presents empirical findings from the analysis of the performance of 85 students from Madison Park High School, Boston, Massachusetts, on the Boston Public Schools City Algebra Test (BPSCAT) in June and August 2000, and how their participation in Jobs for Youth's Boston PLATO computer-based instruction in the intervening months may have affected their achievement. It was determined that the number of PLATO modules completed has a positive and statistically significant effect on the change in test scores, and that the significance of this effect is robust to a number of factors. All analyses were conducted with Stata version 7.0. (Author/SLD)

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Evaluation of Madison Park PLATO Training on August 2000 BPS City Algebra Test Achievement

Christopher F. Baum

October 1, 2001

This report presents empirical findings from the analysis of 85 Madison Park High School students' performance on the BPS City Algebra Test (BPSCAT) in June and August 2000, and how their participation in JFY/Boston's PLATO computer-based instruction in the intervening months may have affected their attainment.We determine that the number of PLATO modules completed has a positive and statistically significant effect on the change in test scores, and that the significance of this effect is robust to a number of factors. All analysis is conducted with Stata version 7.0.

Modeling improvement in BPSCAT performance

The analysis of these data is reasonably considered via ordinary least squares regression, given that the retake score may be viewed as an outcome of the original score and the intervening treatment. The basic model considered is therefore:

$$AUG_i = \beta_0 + \beta_1 PLATOMOD_i + \beta_2 JUN_i + \epsilon_i$$

where AUG_i is the i^{th} student's August 2000 BPSCAT score, JUN_i is the corresponding June 2000 score, and $PLATOMOD_i$ measures the number of PLATO modules completed in the interim. Empirical results from estimation of this model over the full 85-student dataset are shown on line 14 of the attached log file (Model 1). The estimated coefficient on PLATOMOD is highly significant, with a p-value of 0.017[1] and a point estimate of 0.73: each PLATO module

[1]The p-value is the probability of observing a t-statistic of this magnitude if the null hypothesis (that the associated population coefficient is zero) was true.

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completed leads to a 0.73 point increase in the August score, *ceteris paribus*.

Evaluating the robustness of the empirical findings

Given the wide range of values recorded for the dependent variable, there may be some doubt that the assumption of homoskedasticity (a constant variance of the error process ϵ) is appropriate. If the errors are heteroskedastic, the estimated standard errors of the regression coefficients will be biased. This issue may be resolved by reestimating the regression specifying that robust (heteroskedasticity-consistent) standard errors are to be calculated. These results are shown on line 16 (Model 2), in which we see that the robust standard error for PLATOMOD is even smaller than the OLS counterpart, and the interval estimate for that coefficient commensurately smaller.

There may be concern that inclusion of those students who did not complete any PLATO modules (but nevertheless spent some time using the system) may bias the results. To evaluate this concern, the regression is reestimated for the 77 students who completed one or more PLATO modules (see line 18, Model 3). The point estimate of the PLATOMOD coefficient is larger–0.92 versus 0.73–and significant at better than the 99% level, with a regression R^2 of 0.1722: that is, over 17% of the variation in August test score is attributable to the model that takes account of the June score and the PLATO experience.

We are also concerned, when OLS regression is employed, in the presence of outliers. While a greater variance of the explanatory variables is usually helpful in estimating precise estimates, severe outliers may distort the relationship. A tabulation of PLATOMOD shows that one student completed 48 modules, while the next most ambitious student completed only 26. We reestimate the relationship in Model 4 (line 20) excluding both zero values and the extreme value of 48, over the remaining 76 students. The results are qualitatively similar, with an even greater point estimate for PLATOMOD (1.14 points per module completed), significant at greater than the 99% level.

The effect of time spent with PLATO on the test score

One possible critique of these findings would suggest that the mere time spent with the PLATO system will have an effect. While time spent with the system is surely positively correlated with the number of modules completed, we would like to establish that it is mastery of the material–and not merely time spent at the keyboard–that has had an effect on attainment. We first fit a model (line 26, Model 5) in which the *number* of modules mastered is replaced with the amount of time spent, in decimal hours, with the system. That model shows that time spent is not systematically related to the August score, after

controlling for the June score. This result is unchanged if robust standard errors are computed (Model 6, line 28).

Alternatively, we might consider that time is another measure of the "PLATO effect," and include time spent alongside the number of modules completed. In Model 7 (line 33), we see that this model decisively echos the earlier findings: the effects of students' PLATO experience is related to the number of modules completed (PLATOMOD), and not to the time spent with the system. This result is also achieved if robust standard errors are computed (Model 8, line 35).

Summary findings

At any conventional level of statistical significance, the 85 students' August 2000 BPSCAT test scores may be judged to have been meaningfully influenced by their participation in PLATO computer-based instruction, when that participation is quantified as the number of PLATO modules mastered. This finding is robust to a number of forms of the model, and to the presence of heteroskedasticity in the error distribution. It is my reasoned judgment that these results illustrate, beyond a reasonable doubt, that the average student's use of PLATO meaningfully improved his or her test score in the August 2000 retake. Although the interval estimates of the magnitude of this effect are broad, due to the limited sample size and high variance of the August 2000 scores, they decisively exclude zero, and allow us to objectively conclude that the use of PLATO was highly beneficial for the representative student. A graphical illustration of this phenomenon is provided in the attached Figure, which presents a smoothed version of Model 4's predicted values for the sample values of PLATOMOD. The positive slope of this line is indicative of the general improvement in August 2000 scores accruing to those students who made greater efforts to master PLATO modules.

Background

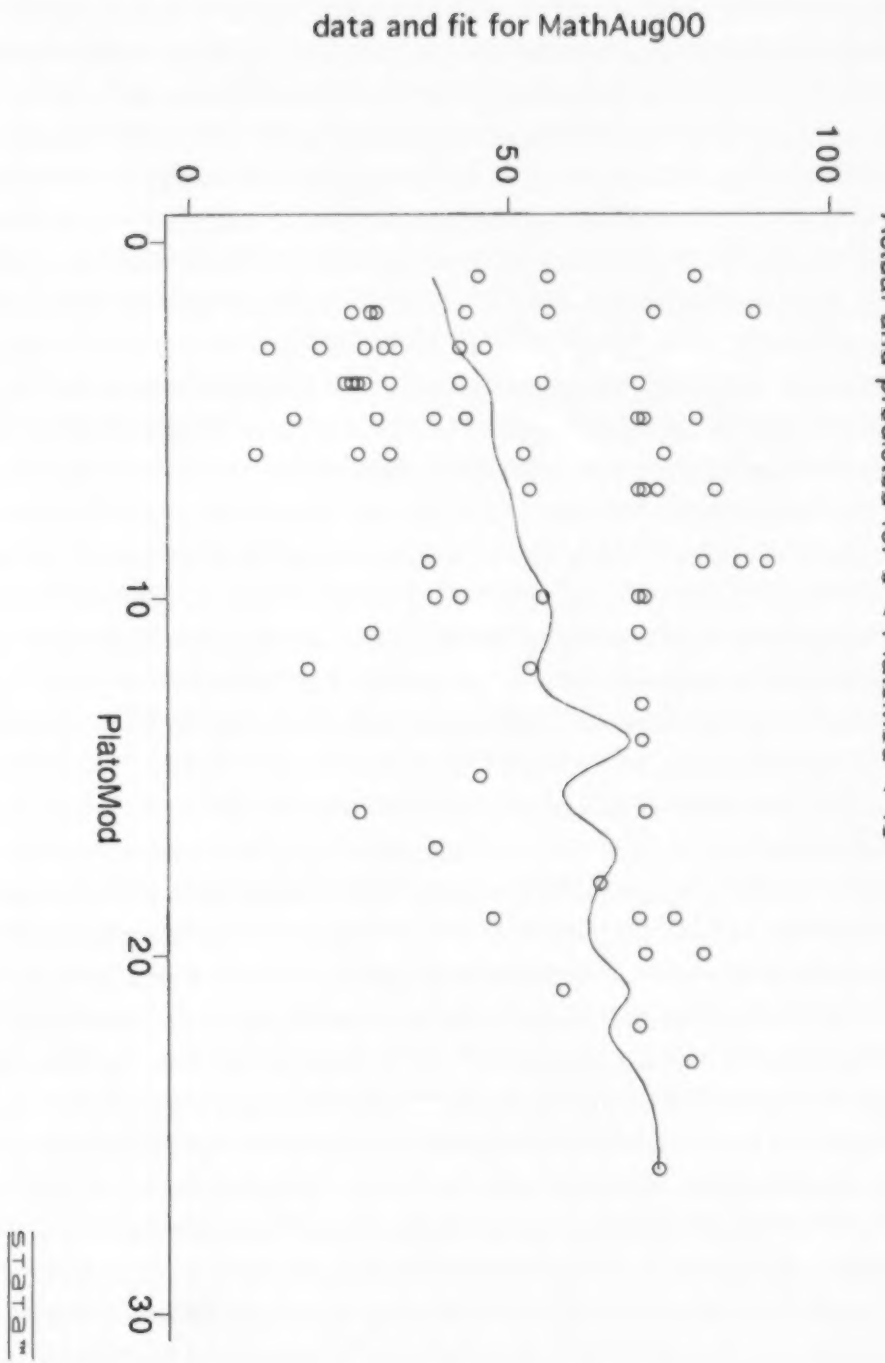
Dr. Christopher F Baum is an associate professor of economics at Boston College. He joined the BC faculty after earning the Ph.D. in economics from The University of Michigan–Ann Arbor in 1977. Baum has taught econometrics at the Ph.D. level for the past 20 years, as well as undergraduate econometrics and computational economics, and has authored over 30 refereed publications in applied economics and finance, including several related to program evaluation. He directs the University's Graduate Statistical Assistant Program, established in 2000, and is an associate editor of *Computational Economics* and *The Stata Journal*.

```
      log:  :Rumelihisari:Stetson:[documents]:JFY-Boston:BPSCAT.log
  log type:  text
 opened on:   1 Oct 2001, 20:05:30

1 . use "BPSCAT.dta", clear

2 .
3 . * generate time measurement
4 .
5 . gen time=real(substr(platotime,1,index(platotime,":")-1))+real(substr(platotime,ind
  > ex(platotime,":")+1,.))/60
  (4 missing values generated)

6 .
7 . * descriptives
8 .
9 . summ math* platomod time

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
    mathjun00 |        85    32.04706    14.36236         6       68.5
    mathaug00 |        85    51.97647    21.82887        10         90
     platomod |        85    7.894118    7.739853         0         48
         time |        81    10.28416    4.495312         0   19.16667

10 .
11 . * test model of retake as function of number of modules completed and orig score
12 .
13 . * (1)
14 . regress mathaug00  platomod mathjun00

      Source |       SS       df       MS              Number of obs =      85
-------------+------------------------------           F(  2,    82) =    6.25
       Model |  5297.99104     2  2648.99552           Prob > F      =  0.0030
    Residual |  34727.9619    82  423.511731           R-squared     =  0.1324
-------------+------------------------------           Adj R-squared =  0.1112
       Total |  40025.9529    84   476.49944           Root MSE      =  20.579

------------------------------------------------------------------------------
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    platomod |   .7303854   .3000386     2.43   0.017     .1335131    1.327258
   mathjun00 |   .3007251   .1616903     1.86   0.066    -.0209284    .6223785
       _cons |   36.57337   5.583881     6.55   0.000     25.46525    47.68149
------------------------------------------------------------------------------

15 . * (2)
16 . regress mathaug00  platomod mathjun00, robust

Regression with robust standard errors                Number of obs =      85
                                                      F(  2,    82) =    10.32
                                                      Prob > F      =  0.0001
                                                      R-squared     =  0.1324
                                                      Root MSE      =  20.579

------------------------------------------------------------------------------
             |               Robust
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    platomod |   .7303854   .2437015     3.00   0.004     .2455855    1.215185
   mathjun00 |   .3007251   .1760156     1.71   0.091    -.0494261    .6508762
       _cons |   36.57337   5.594281     6.54   0.000     25.44456    47.70218
------------------------------------------------------------------------------
```

```
17 . * (3)
18 . regress mathaug00  platomod mathjun00 if platomod>0

      Source |       SS       df       MS              Number of obs =      77
-------------+------------------------------           F(  2,    74) =    7.70
       Model |  6393.42796     2  3196.71398            Prob > F      =  0.0009
    Residual |  30741.0915    74  415.420156            R-squared     =  0.1722
-------------+------------------------------           Adj R-squared =  0.1498
       Total |  37134.5195    76  488.612098            Root MSE      =  20.382

------------------------------------------------------------------------------
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   platomod  |   .9216613   .3151606     2.92   0.005     .2936901    1.549632
  mathjun00  |   .2896614   .1636177     1.77   0.081    -.036354     .6156769
       _cons |   34.02281   5.772744     5.89   0.000     22.52037    45.52526
------------------------------------------------------------------------------

19 . * (4)
20 . regress mathaug00  platomod mathjun00 if platomod>0 & platomod<48

      Source |       SS       df       MS              Number of obs =      76
-------------+------------------------------           F(  2,    73) =    7.28
       Model |  6047.81182     2  3023.90591            Prob > F      =  0.0013
    Residual |  30315.0698    73  415.274928            R-squared     =  0.1663
-------------+------------------------------           Adj R-squared =  0.1435
       Total |  36362.8816    75  484.838421            Root MSE      =  20.378

------------------------------------------------------------------------------
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   platomod  |    1.14167   .3827197     2.98   0.004      .378911    1.90443
  mathjun00  |   .3024267   .1640739     1.84   0.069    -.0245721    .6294256
       _cons |   32.02899   6.098194     5.25   0.000     19.87531    44.18267
------------------------------------------------------------------------------

21 . regplot, t1("Actual and predicted for 0 < PlatoMod < 48") saving(predval,replace)

22 .
23 . * test model of retake as function of time spent and orig score
24 .
25 . * (5)
26 . regress mathaug00  time mathjun00

      Source |       SS       df       MS              Number of obs =      81
-------------+------------------------------           F(  2,    78) =    3.64
       Model |  3304.43459     2   1652.2173            Prob > F      =  0.0307
    Residual |  35373.4419    78  453.505666            R-squared     =  0.0854
-------------+------------------------------           Adj R-squared =  0.0620
       Total |  38677.8765    80  483.473457            Root MSE      =  21.296

------------------------------------------------------------------------------
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        time |   .5230609   .5297404     0.99   0.327    -.5315712    1.577693
  mathjun00  |   .4071025   .1632792     2.49   0.015     .0820387    .7321664
       _cons |    32.8949   7.877176     4.18   0.000     17.21265    48.57716
------------------------------------------------------------------------------
```

```
27 . * (6)
28 . regress mathaug00  time mathjun00, robust

Regression with robust standard errors                Number of obs =      81
                                                      F(  2,    78) =    3.69
                                                      Prob > F      =  0.0294
                                                      R-squared     =  0.0854
                                                      Root MSE      =  21.296

------------------------------------------------------------------------------
             |               Robust
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        time |   .5230609   .5878957     0.89   0.376    -.6473495    1.693471
   mathjun00 |   .4071025   .1667289     2.44   0.017     .0751707    .7390343
       _cons |    32.8949   8.285842     3.97   0.000     16.39906    49.39075
------------------------------------------------------------------------------

29 .
30 . * add time spent to original model
31 .
32 . * (7)
33 . regress mathaug00  platomod time mathjun00

      Source |       SS       df       MS              Number of obs =      81
-------------+------------------------------           F(  3,    77) =    4.88
       Model |  6176.95105     3  2058.98368            Prob > F      =  0.0037
    Residual |  32500.9255    77  422.089942            R-squared     =  0.1597
-------------+------------------------------           Adj R-squared =  0.1270
       Total |  38677.8765    80  483.473457            Root MSE      =  20.545

------------------------------------------------------------------------------
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    platomod |   .8672367   .3324367     2.61   0.011     .2052708    1.529203
        time |  -.0341183   .5538977    -0.06   0.951    -1.13707     1.068833
   mathjun00 |   .2982756   .1629525     1.83   0.071    -.0262043    .6227555
       _cons |   34.95827   7.640491     4.58   0.000     19.74411    50.17243
------------------------------------------------------------------------------

34 . * (8)
35 . regress mathaug00  platomod time mathjun00, robust

Regression with robust standard errors                Number of obs =      81
                                                      F(  3,    77) =    7.59
                                                      Prob > F      =  0.0002
                                                      R-squared     =  0.1597
                                                      Root MSE      =  20.545

------------------------------------------------------------------------------
             |               Robust
   mathaug00 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    platomod |   .8672367   .2798133     3.10   0.003     .3100573    1.424416
        time |  -.0341183   .6048935    -0.06   0.955    -1.238615    1.170378
   mathjun00 |   .2982756   .1799907     1.66   0.102    -.0601316    .6566828
       _cons |   34.95827   8.534039     4.10   0.000     17.96483    51.95171
------------------------------------------------------------------------------
```

```
36 .
37 . log close
          log:  :Rumelihisari:Stetson:[documents]:JFY-Boston:BPSCAT.log
     log type:  text
    closed on:   1 Oct 2001, 20:05:35
   ------------------------------------------------------------------------------
```


data and fit for MathAug00
Actual and predicted for 0 < PlatoMod < 48
100
50
0
0
10
20
30
PlatoMod
stata™

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